Policy Implications from 'Late Lessons from Early Warnings: The Precautionary Principle 1896-2000'

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Policy Implications from 'Late Lessons from Early Warnings: The Precautionary Principle 1896-2000'

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Introduction

Policymakers face the unenviable task of making difficult decisions on behalf of society in situations of uncertainties, ignorance, and high stakes. In doing so, they will want to avoid the mistakes of the past. The European Environment Agency has published a book in an attempt to evaluate the history of mistakes of the past: "The Precautionary Principle - Late Lessons from Early Warnings 1896-2000". The primary lessons synthesised from 14 case studies are summarised in the report (EEA, 2001, Harremoës et al., 2002). This paper will focus and further elaborate on key issues arising from the "Late Lessons from Early Warnings" book. The idea is to extract the issues, which may help policymakers and the public to identify ways of avoiding such mistakes in the future. Some of these issues are raised in the European Commission Communication on the Precautionary Principle (EC, 2000), and in other related policy proposals: some relevant extracts are therefore included.

The precautionary principle is a frame of thinking that governs the use of foresight in situations characterised by uncertainty and ignorance and where there are potentially large pros and cons of both regulatory action and inaction. Within this frame of thinking there are a number of interpretations, approaches and concrete actions that can be taken to implement the principle. This paper is a synthesis of the lessons, translated and elaborated to address an audience facing the dilemmas associated with the decision making regarding issues involving high stakes combined with uncertainty and ignorance.

The issues will be addressed on the basis of three different interpretations of the lessons learned from the "Late Lessons from Early Warnings" book:

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1. **Normative interpretation,** experience due to ignored warnings.
   How can policymakers reduce the chances and impacts of surprises? How long can it take between first exposures to harmful agents, their damaging impacts, and recovery? How valuable is long term monitoring? Does more research reduce scientific uncertainties?
2. **Balanced proof interpretation** of evidence of benefits and harm.
   How much evidence of harm is needed to justify precautionary action? Who carries the burden of proof of "safety"?
3. **The 'pro et con' interpretation**
   What is a broad interpretation of the Precautionary Principle? How comprehensive were the assessments of the costs and benefits of precautionary action/inaction?

Terminology

It is important to distinguish between three terms: Precautionary principle, precautionary approach and precautionary action.

- The precautionary principle can be interpreted as a framework of thinking that governs the use of foresight in situations characterized by uncertainty, ignorance and ambiguity, and where there are potentially large pros and cons of both regulatory action and inaction. As a principle it has a legal standing that has implications on the application of the principle in the international arena. In the European Union, precaution is interpreted as a principle and has legal standing, and has been adopted as such in the EU Maastricht Treaty of 1992 (EU, 1992).
- The precautionary approach is a way of doing things along the same lines of thought as outlined above, but an approach has no legal standing. In international trade disputes, USA tends to interpret the precautionary principle as an approach and not a principle having legal standing.
- A precautionary action is a measure taken to implement the thoughts behind the principle.

Normative interpretation

Policy statements for reduction of the risks and impacts of surprises

The case studies show that some actions can help anticipate, identify earlier or minimise the impact of "surprises". The following statements have the character of normative statements, by which the risks and impacts of surprises due to uncertainty and ignorance can be reduced:

- **Use knowledge of the intrinsic properties of a substance or activity** when assessing possible impacts, e.g.. If a chemical substance is persistent or it bioaccumulates, a long-term effect that may be hazardous should not be disregarded.

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- **Reduce irreversibility, where possible.** This is a good general principle, due to the mere fact that any error in the risk assessment may have long lasting negative effects and may even be impossible to remediate, CFCs, PCBs, MTBE (climate change), etc.
- **Use a diversity of robust and adaptable technological options to meet needs**. This helps to limit technological "monopolies" such as that of asbestos, CFCs, PCBs, etc. and thereby the scale of the surprise.
- **Use a variety of scientific disciplines** as well as "lay" and "local" knowledge in risk assessments
- **Reduce specific exposures to potentially harmful agents** on the basis of credible early warnings of *initial* harmful impacts, thus limiting the size of any *other* surprise impacts from the same agent. Eg asbestos, PCBs.
- **Reduce the general use of energy and materials** via radically greater (e.g. 10 times) *eco-efficiencies*, so as to reduce overall environmental burdens, thereby limiting the scale of future surprises.
- **Use liability measures** (e.g. legal duties and insurance bonds) to compensate for potentially harmful impacts and to provide an investment fund in case "surprise" occurs.
- **Use of prospective analyses and scenarios.** These help foresee unintended consequences.
- **More long-term environmental and health monitoring and more research on cause-effect relationships** to enable "early warnings" of surprises.
- **Better dissemination of research results for improved "early warnings" detection.**

Time lag from exposures to impacts versus time to recovery

There is a systematic discrepancy between the time lag from the first exposures to harmful impacts on the one side and the time to recover from such harmful impacts after the chain of events has started to unfold. This time element is essential, because it reveals a systematic tendency to be late with regulatory actions, even when responding to early warnings. The conclusion is that it is never too early to address an issue at the first indications, even suspicions of harmful effect. Subsequently, the actions to be taken depend on the character of the indications and the options available, varying from intensified research and monitoring to regulatory actions.

Table 1 illustrates with examples from the case studies.

Table 1: Time to Harm and Time to Heal?

Chapter	Time to Harm	Time to Heal
Asbestos	Asbestosis (10-25 years)	Irreversible disability
	Lung cancer (10-30 years)	Death (1-5 years)
	Mesothelioma cancer (20-50 years)	Death (1-2 years)
CFCs	"Hole" in ozone layer (30-70 years)	Slow recovery (50-100 years)
	Skin cancer (30-40 years after exposure to higher UV radiation)	Recovery or death depending on cancer type (2-30 years)
	Reduced immune response (0-5 years?)	Temporary or permanent?
	Plant productivity (0-12 months)	Depends on species
DES	Cancer in 2nd generation (25-35 years)	Recovery or death (5-20 years)

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MTBE	Groundwater contamination (1-25 years)	"Permanent" (i.e. many decades)
PCBs	Cancer (10-25 years)	Recovery or death (2-40 years)
	Neurotoxicity (2-40 years)	Permanent damage?
Fishing	Depleted or destroyed stocks (decades)	Temporary or permanent losses (years-decades)
Radiation	Cancer (5-40 years)	Recovery or death depending on type (2-30 years)
Acidification of lakes	Sulphur depositions from fossil fuels acidifies lakes (20-50 years)	Recovery, even with artificial liming of lakes, is taking several decades; fish can take another 20 years to recover after that.

Source: EEA . "Time to Harm and Heal" concepts were inspired by Swedish EPA, 2001

The time taken for evidence of impacts to emerge is also relevant to the generation of "false negatives**",** i.e. harmful substances or activities that were once considered to be not harmful. For example, "experience with human cancer shows that, in some cases, the period from first exposure to the development of clinical cancer is seldom less than 20 years: latent periods substantially shorter than 30 years cannot provide evidence for lack of carcinogenicity" (Vainio et al, 1992). Therefore epidemiological surveys showing no evidence of late developing cancers, where the period since first exposure is less than 20 years, may provide poor evidence for a lack of carcinogenicity. It is this long "time to harm and then time to heal" that often justifies use of the precautionary principle in public policymaking.

The costs of applying the precautionary principle must not be disproportionate to the benefits expected, (*the "proportionality principle")* but when the benefits from avoided harm lie far out in the future, proportionality is harder to assess, as the Communication from the European Commission points out- see Box.1.

Box 1: Proportionality and time

"Measures based on the precautionary principle must not be disproportionate to the desired level of protection … The risk reduction measure should not be limited to immediate risks where the proportionality of the action is easier to assess. It is in situations in which the adverse effects do not emerge until long after exposure that the cause-effect relationships are more difficult to prove scientifically and that - for this reason – the precautionary principle often has to be invoked. … Risks that are carried forward into the future cannot be eliminated or reduced except at the time of exposure, that is to say immediately".

(CEC Communication on the Precautionary Principle, 2000, para. 6.3.1)

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Balanced proof interpretation

The level and burden of proof of harmful effects used in decision making is the main element in what could be called the "balanced proof" interpretation of the precautionary principle. The interpretation is expanded from a simplistic interpretation based on normative statements about how to act to an analytical interpretation where a balance has to be achieved between alternative interpretations of the basis for action. The main point is that decisions regarding provision and evaluation of evidence depend on the situation of concern. It is a predominant philosophy that an activity, a structure, a chemical is considered harmless until proved harmful. It is up to the opponent to prove harmfulness in a liability case against the promoter of the activity. That burden of "proof" can be very hard to lift. The basic question is whether this common attitude is fair. It is not a question of science, interpreted as natural science. It is a question of fairness, which is an ethical issue to be addressed by the policy makers. As will be shown below, society has realised this on numerous occasions in the past, and has introduced regulatory measures in order to deal with that very issue. The Precautionary Principle is just a mere step in analysing the fairness issue resulting from uncertainty and ignorance in the regulatory process.

3.1 Level of evidence

Various international agreements invite use of the Precautionary Principle when there is "less than full scientific certainty" over the link between the potentially hazardous activity and harmful impacts; but they do not indicate what "less than" means**.** As we have seen above, this "triggering factor" can involve establishing just "reasonable grounds for concern", according to the EU Communication on the Precautionary Principle. This evidence need not include quantifiable estimates of risk (see Box 2).

Box 2 "The Triggering Factor"

"Once the scientific evaluation has been performed … it may provide a basis for triggering a decision to invoke the precautionary principle. … The absence of scientific proof of the existence of a cause-effect relationship, a quantifiable dose/response relationship, or a quantitative evaluation of the probability of the emergence of adverse effects … should not be used to justify inaction. Even if scientific advice is supported by a minority fraction of the scientific community, due account should be taken of their views, provided the credibility and reputation of this fraction are recognised".

(CEC Communication on the precautionary principle, 2000, para. 6.2)

In general, as the case studies illustrate, the high level of proof that is appropriate for good, natural science is rarely appropriate for the very different activity of sound

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policymaking in situations of serious and possibly irreversible hazards, where lower levels of proof, such as the "balance of evidence", may be more appropriate.

There are different levels of proof used for different purposes in society and the choice as to which level of proof to use in which circumstances, is essentially an ethical rather than a scientific question, as the following examples illustrate.

For example, criminal trials use a high level of proof, ("beyond all reasonable doubt") where the "cost" of being wrong in one direction i.e. innocent people being jailed, or sometimes executed, is regarded as being less acceptable than being wrong in the other direction (i.e. guilty people going free).

For other legal purposes, such as compensating people who have been injured through accidents, a lower level of proof is often used in the courts, e.g.: "the balance of probabilities". Society considers that the costs of being wrong in using this lower level of proof i.e. compensating injured people for injuries that were not caused by the negligence of others, is more ethically acceptable than being wrong in the other direction, i.e. not compensating people for the injuries that were caused by the negligence of others.

In science, a high level of proof is also used, such as "reasonable certainty". Scientists consider that it is less damaging for science when a new scientific hypothesis that fails to reach this high level of proof eventually turns out to be correct (called a "false negative") than when a hypothesis is initially accepted which later proves to be incorrect (a "false positive") (Cranor, 1999 and Harremoës, 2003).

But which level of proof is appropriate for public policy decision-making on potentially hazardous substances or economic activities?

The higher the level of proof used in evaluating the scientific evidence on potentially hazardous substances, the greater the chance that there will be "false negatives". For example, substances like asbestos and benzene were regarded as safe until much evidence of harm had been assembled. Similarly, waiting for "convincing " evidence of over-fishing can lead to misplaced confidence in the harmlessness of current fishing activities. In both cases choosing lower levels of proof can avoid the costly "false negatives" described in the case studies. However, the lower the level of proof used in decision making the greater the chance of identifying "false positives" i.e. regarding substances or activities as harmful but which turn out to be harmless. Choosing appropriate levels of proof for policymaking therefore involves choosing between the likelihood and costs of being wrong, i.e. between restrictions on an economic activity that turn out to be unnecessary, or no restrictions on the economic activity that turns out to be harmful, sometimes irreversibly so.

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Burden of proof

The basic principle in western societies is that an activity is harmless until proven harmful. It is the accusing party that have to prosecute the promoter of the activity in order to stop the activity and claim compensation for any harm done by the activity.

In recent years, the liability of the promoting party has been strengthened and liability has become a regulatory mechanism of increasing importance. However, the case studies show eloquently that it can be very difficult indeed for laymen to provide evidence of harmfulness - not the least when the proof of harm has to stand up to the rigour of scientific proof. This prevalent condition has been regulated in order to compensate for the virtual impossibility of this demand on laymen and the lack of fairness. Either a "regulatory authority" has taken over the "burden of proof" on behalf of society or the "burden of proof" has been transferred to the promoter of the activity.

Table 2 illustrates the location of the burden of proof for some key economic activities in the EU.

Whether the burden of proof is currently allocated to the promoter of the activity or to a public authorities, depends upon whether the activity is considered to be intrinsically harmful, e.g. pesticides, or, as with “existing” chemicals, whether it was practical to establishing post-market testing for thousands of chemicals. The Swedish Chemicals Act 1975 provides a clear illustration of both different **levels of proof** and different locations of the **burden of proof** in the same legislation. It requires the Public Authority to take precautionary action on a chemical substance based on a “scientific suspicion of risk” but then the burden of proof passes to the producer of the substance, who has to show that it is harmless “beyond all reasonable doubt”. This example illustrates that a high level of proof is needed to show harmlessness when there is already evidence of potential hazard, whereas a lower level of proof is needed to demonstrate potential harm when harmlessness is assumed.

The basics of level and burden of proof is:

- If the a-priory assumption is that the activity is **harmless** and the activity is not regulated, then the burden of proof rests with the layman, who by tradition has to show a **high level of evidence of harmfulness** in court to demand stop of the activity and claim compensation. The question is whether this is fair?
- If the a-priory assumption is that the activity is **harmful** and an authority is in charge of regulation, then the burden of proof on the part of the authority require a **lower level of proof** as the basis for regulation. On the other hand, the burden of proof rests with the promoter of an activity, if the promoter seeks exemption from regulation, then the promoter has to provide a **high level of proof** in order to demonstrate **harmlessness**.

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Table 2: Who has the burden of proving

'No Unacceptable Harm*[1]'? Some EU examples:

	Burden of Proof mainly on:	
Economic Activity:	**Producer**	**Public Authorities**
Medicines	√	
Pesticides	√	
Food Additives	√	
Power Stations	√	
"New"*[2] Industrial Chemicals	√	
"Existing" Industrial Chemicals		√
Fishing		√
Many new technologies*[3]		√

✓ = carries the main burden of proof: either on producers as part of specific marketing authorisation or permitting procedures; or on Public Authorities when needing to demonstrate harm from already permitted activities

Producer = those who propose to market the substance, agent or activity

Public Authorities = the publicly funded authorities responsible for specifically authorising or permitting the substance etc; or who identify harm from existing activities

*1: Confidence in this level of 'safety' depends upon the extent and quality of the "pre-market" assessment and testing

*2:'New' means chemicals placed on the EU market after 1981. All others (some 70-100 000 substances) are registered as 'existing' in the European Inventory of Existing Commercial Substances (EINECS). See *Chemicals in Europe: Low Doses, High Stakes?* (EEA/UNEP, 1998)

*3: There are some pre-market safety standards to be met for some consumer products.

- If the a-priory assumption is that the activity is **harmful** and the promoter of an activity has the burden of proof, then the promoter has to provide a **high level of proof** in order to demonstrate **harmlessness**.

It has to be noted that it is virtually impossible to prove harmlessness, because it is in principle impossible to cover all circumstances. The level of proof has to be lowered to a level that can be achieved in practise. The tool is to establish procedural

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mechanisms and institutions that generate confidence in society. It is possible to prove harmfulness, because just one substantial case is in principle enough. However, in practise it can be very difficult to do so. The choice is a question of fairness and equity. Who shall bear the burden of the risks of harmfulness? It is a political decision to decide: What is the a-priori assumption? Who should carry the burden of proof? What level of proof should be demanded?

In general, carrying the burden of proving a reasonable degree of "safety" - for ultimate proof of safety is impossible- provides an incentive to avoid harm, which is one reason why applying the precautionary principle involves placing the burden of proof on the proponents of an activity-see Box 3

Box 3 The burden of proof

Action taken under the head of the precautionary principle must in certain cases include a clause reversing the burden of proof and placing it on the producer, manufacturer or importer, but such an obligation cannot be systematically entertained as a general principle. This possibility should be examined on a case-by-case basis".

(CEC Communication on the Precautionary Principle, 2000, para. 6.4)

The EU White Paper on "Chemicals Strategy" (2001) proposes a gradual switch of the burden of proof for **existing chemicals** from the "Public Authorities" to the "Producers".

The case studies illustrate that the burden of proving pre-market "safety" may also involve obligations to :

- **justify** the technology in relation to the benefits claimed, as with radiation; and to
- **show that alternative ways** of meeting needs are likely to be more hazardous or disproportionately costly, as with the French asbestos ban, and, implicitly, in most of the case studies.

Such "comparative risk assessment" is required under the EU Biocides Directive.

The case studies also show the value of such post-marketing actions by producers as:

- **monitoring** the impacts of the technology; and
- **investigating "early warnings"**.

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The 'pro et con' interpretation

The "pro et con" interpretation involves the whole spectrum of analyses of the issues associated with the Precautionary Principle. Precaution cannot stand alone, but has to be viewed in combination with other principles, that are part of governance of society. The ultimate interpretation is a balancing act between various concerns, values and ethical, judicial and political judgement.

The Precautionary Principle deals with the grey transition from what we know to what we do not know. This grey zone of transition is characterised by uncertainty and ignorance. It is in this zone that new developments provide the chances of benefits and the risks of harm. It is in this grey zone that ideas give rise to innovations and suspicions give rise to fear of harm. In both cases, the characteristic is that we may not know the consequences, success or failure. The Precautionary Principle is the result of a growing awareness of an imbalance between the high esteem for innovations and the disregard for suspicions. The principle is an attempt to shift that balance in favour of an increased awareness of the uncertainties and the ignorance, which tend not to be recognised in the process of decision making in the grey zone of transition. A key to the interpretation is that this grey zone of transition is not only governed by scientific approaches, but as much by intuition with regard to ideas for development and for suspicions of potential harm. Accordingly, the regulation of this zone should not be governed solely by scientific judgement of proof, but should be governed by society on the basis of principles associated with a balance based on social, judicial, political and ethical sciences and concerns.

The balance of the Precautionary Principle

Box 4 provides a broad interpretation of the precautionary principle that arises from the "Late lessons" report. It includes the "balanced proof " interpretation, which focuses on the level of proof needed for regulatory action, and embraces other features that are needed to help deal with situations of uncertainties, ignorance and high stakes. The elements included below build on the German and some US interpretations, in light of the Case Studies and the "Late Lessons from Early Warnings" book.

Box 4 A broad interpretation of the Precautionary Principle arising from "Late Lessons from Early Warnings".

The Precautionary Principle is a framework of thinking that governs the use of foresight in situations characterized by uncertainty and ignorance and where there are potentially large pros and cons of both regulatory action and inaction.

Two main types of policy actions:

- *Precautionary action to reduce harm in the face of scientific uncertainty using an appropriate level of proof; and*
- *Proportional action so that the likely costs of precautionary action does not grossly outweigh the likely benefits.*

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Plus five other main features:

- *A commitment **to monitoring/detecting** "early warnings" via research and long-term environmental and health monitoring*
- ***Maximizing stakeholder participation** in the assessment and management of potentially harmful economic activity so as to minimise the overall "harm/costs of being wrong" (including political, economic and health harm/costs)*
- ***Integrated, comprehensive and transparent assessments** of technologies, activities and potential hazards based on scientific, lay, and local knowledge and evidence, and covering all pros and cons*
  - *of the economic activity (or agent)*
  - *of alternatives and*
  - *of a variety of actions/inactions to minimise the cons and maximize the pros.*
- *Open recognition of uncertainties, of **gaps in knowledge** and their research implications*
- *Maximizing the **incentives for harm prevention** via the "polluter pays principle"; a better balance between the generation of "false negatives" and "false positives"; changing the paradigm to "harmful unless proven harmless" and locating the burden of proof of "safety" on the technology producer.*

Comprehensive assessments of "pro et cons"

In the "Late Lessons from Early Warnings" book the term: "pro et con" was used, because it was found that the usual term: "cost and benefit" was a term associated with a lot of misunderstanding and conflict. Such misunderstandings/conflicts are based on two frequently held views on "cost and benefit": Environmental issues are not suitable for cost-benefit analysis, because it is a common perception that cost-benefit does not and cannot incorporate non-economical concerns, like long term value of nature (a view contested by some environmental economists) and that economically dominated cost-benefit analyses have been misused as an instrument for preconceived ideas about regulation. As a consequence, the term: "pro et con" is the term of choice to characterise the balance between all opposing concerns.

Much policymaking in the case studies was based on assessments that had significant gaps, particularly concerning:

- **non-economic** aspects and wider pros and cons
- **justification of** the benefits claimed for the technology
- **alternative** ways of meetings needs;
- **secondary or spillover benefits**, additional to the main benefit; and
- **distribution** of benefits and harm between groups in society and between generations.
- decisions based on a small group of experts **without consultation and participation** of a wider audience of the public, who may have different sets of values compared to a select group of experts.

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For example, the *benefits* of the hazardous substance, or economic activity, were not subject to much critical scrutiny but accepted as obviously proven by, for example, increased economic activity or sales of the substance. Radiation is an exception, where a formal "justification" of benefits has long been required, but here too the case study shows some uses of radiation that were of little benefit, yet they carried significant risks.

This failure to scrutinise benefits, combined with the failure of the market prices of the hazardous agents to reflect full environmental and health costs, also held up the development and sale of *alternatives* to the hazardous technology. When alternatives were developed they often turned out to be technically and, from society's viewpoint, economically superior. Better analysis of alternatives at an earlier stage of the technology assessment can stimulate innovation.

"No regrets" precautionary policy measures are where the secondary benefits are likely to exceed the overall costs of achieving them, thereby making them cost-effective even if the primary (and sometimes less certain benefit) does not materialise. A current example is where the reduction of fossil fuel combustion to combat climate change can produce quick and large secondary gains from the health benefits of cleaner air. Similarly, the cost of the EU programme to combat acidification from sulphur dioxide and other pollutants is much higher if fossil fuel targeted climate change policies are not being adopted at the same time. Broad, integrated assessments of technologies are needed to capture these interconnections of the real world.

In all cases studies, *non-economic considerations* needed to be included in any broad assessment of the overall pros and cons of the economic activity. – see Box.5

Box 5 The benefits and costs of action and lack of action

"The measures adopted presuppose examination of the benefits and costs of action and lack of action. This examination should include an economic cost/benefit analysis when this is appropriate and feasible. However, other analysis methods, such as those concerning efficacy and the socio-economic impact of the various options, may also be relevant. Besides the decision-maker may, in certain circumstances, be guided by non-economic considerations such as the protection of health.

"(CEC Communication on the Precautionary Principle, 2000, para. 6.3.4)

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It is noteworthy that several of the case studies hazards originated from the desire to be sustainable by recycling wastes into more useful products (e.g. BSE, AFA): the potential benefits and hazards of recycling need careful scrutiny.

The *distribution* of benefits and harm between different groups was often poorly analysed, particularly between generations. Many of the case study subjects had "long-tail" effects lasting several decades into the future.

However, there is a mismatch between the timescales used by most markets, politicians, consumers and businessmen (minutes to 5 years) and the timescales needed to protect fish, observe cancers or reverse acidification, and ozone layer damage. (decades to centuries).

In most of the case studies, future costs were often largely ignored or discounted (implicitly or explicitly) to today's values. This is a common way of "externalising" some of today's costs of production onto future generations .The EU is currently proposing liabilities legislation to help remove this market distortion -see Box.6. Some economists have proposed liabilities bonds as a means of dealing with the costs of future but unknown impacts (Cornwell and Costanza, 1999)

Box 6 EU White Paper on Environmental Liability

"Reasons for introducing an EC liability regime include improved implementation of key environmental principles (polluter pays, prevention, and precaution) and of existing environmental laws (P7)

...environmental liability results in prevention of damage and in internalisation of external costs. Liability may also lead to the application of more precaution, resulting in avoidance of risk and damage and may encourage investment in R&D for improving knowledge and technologies" (p14)

(European Commission "White Paper on Environmental Liability", Com (2000) 66 final feb.)

Detecting "unknown" liabilities that may arise in the future requires some form of long term monitoring, but was this kind of information available in the case studies?

It can take many years to discover the biological or ecological mechanisms that explain a link between activities and harmful impacts, e.g. the 30 years between observing the association between polluted water and cholera and identifying the cholera vibrio, which explained the link. Precautionary action on reducing impacts often has to anticipate knowledge of mechanisms by many years. In the case studies there are still many scientific unknowns several decades after the early warnings of harmful impacts were identified, despite years of research.

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The key features of the broad interpretation of the Precautionary Principle in relation to comprehensive, integrated analysis, assessment and decision making are:

- incorporate all concerns of all stakeholders in framing the issue
- account for all "pro et cons" in the analysis and assessment
- explicitly account for the risk of being wrong due to uncertainty and ignorance, and for the potential consequences of wrong decisions
- demonstrate accountability and transparency in the analysis and assessment in order to generate confidence
- consult all parties, stakeholders and the public by participation to account for different values and priorities
- weigh all factors against each other in the process of decision making
- communicate the decision and the basis for it, for all to know.

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